

WHAT IS CLAIMED IS:

1. A control apparatus for an engine, the engine having a variable lift mechanism that is capable of changing a lift amount of a valve of the engine and a variable compression ratio mechanism that is capable of changing a compression ratio in a combustion chamber of the engine, comprising:

a control unit configured to control the variable lift mechanism and the variable compression ratio mechanism so that a rate that the compression ratio decreases is faster than a rate that the lift amount increases when a requested engine output is increasing.

2. The control apparatus of claim 1, wherein the engine further has a variable phase mechanism that is capable of changing a phase of the valve;

wherein the control unit is further configured to control the variable compression ratio mechanism and the variable phase mechanism so that a rate that the compression ratio decreases is faster than a rate that the phase is retarded when the requested engine output is increasing.

3. A control apparatus for an engine, the engine comprising a variable lift mechanism that is capable of changing a lift amount of a valve of the engine and a variable compression ratio mechanism that is capable of changing a compression ratio in a combustion chamber of the engine, comprising:

a control unit configured to control the variable lift mechanism and the variable compression ratio mechanism so that a rate that the lift amount decreases is faster than a rate that the compression ratio increases when a requested engine output is decreasing.

4. The control apparatus of claim 3, wherein the engine further comprises a variable phase mechanism that is capable of changing a phase of the valve;

wherein the control unit is further configured to control the variable
5 compression ratio mechanism and the variable phase mechanism so that a rate that the phase is advanced is faster than a rate that the compression ratio increases when the requested engine output is decreasing.

5. A control apparatus for an engine, comprising:

10 a compression ratio controller for controlling a compression ratio in a combustion chamber of the engine so that the compression ratio converges to a desired compression ratio;

a lift controller for controlling a lift amount of a valve of the engine so that the lift amount converges to a desired lift amount; and

15 a master-slave switching unit for selecting one of the compression ratio and the lift amount as a master parameter and selecting the other as a slave parameter based on a requested engine output, the switching unit designating one of the compression ratio controller and the lift controller that controls the master parameter as a master controller, the switching
20 unit designating the other of the compression ratio controller and the lift controller that controls the slave parameter as a slave controller;

wherein the master controller determines a desired value for the master parameter based on the requested engine output, and controls the master parameter to converge to the desired value,

25 wherein the slave controller determines a desired value for the slave parameter based on an actual measured value of the master parameter that is acquired as a result of controlling the master parameter, and controls the slave parameter to converge to the desired value,

wherein the control of the master parameter and the control of the
30 slave parameter allow a changing rate of the master parameter to be faster

than a changing rate of the slave parameter.

6. The control apparatus of claim 5, further a phase controller for controlling a phase of the valve of the engine so that the phase converges to
5 a desired phase,

wherein the master-slave switching unit selects one of the compression ratio, the lift amount and the phase as a master parameter, and selects the others as slave parameters based on the requested engine output,

10 wherein the master slave switching unit designates one of the compression ratio controller, the lift controller and the phase controller that controls the master parameter as a master controller, and designates the others as slave controllers.

15 7. The control apparatus of claim 5, wherein the master-slave switching unit selects the compression ratio as the master parameter and selects the lift amount as the slave parameter when the requested engine output is increasing.

20 8. The control apparatus of claim 5, wherein the master-slave switching unit selects the lift amount as the master parameter and selects the compression ratio as the slave parameter when the requested engine output is decreasing.

25 9. The control apparatus of claim 6, wherein the master-slave switching unit selects the compression ratio as the master parameter and selects the lift amount and the phase as the slave parameters when load of the engine is extremely low and the requested engine output is increasing.

30 10. The control apparatus of claim 6, wherein the master slave

switching unit selects the phase as the master parameter and selects the lift amount and the compression ratio as the slave parameters when load of the engine is extremely low and the requested engine output is decreasing.

5 11. The control apparatus of claim 6, wherein the lift controller sets the desired lift amount based on an actual measured value of the phase that is acquired as a result of the control by the phase controller when load of the engine is extremely low.

10 12. The control apparatus of claim 5, wherein the master controller is configured to perform a response assignment control that is capable of specifying a response speed of the master parameter to a desired value,

 wherein the slave controller is configured to perform a response assignment control that is capable of specifying a response speed of the
15 salve parameter to a desired value,

 wherein the master controller sets the response speed of the master parameter so that the response speed of the master parameter is faster than a response speed of the slave parameter.

20 13. The control apparatus of claim 6, wherein the master controller is configured to perform a response assignment control that is capable of specifying a response speed of the master parameter to a desired value,

 wherein the slave controllers are configured to perform a response assignment control that is capable of specifying a response speed of the
25 salve parameters to desired values,

 wherein the master controller sets the response speed of the master parameter so that the response speed of the master parameter is faster than a response speed of the slave parameters.

30 14. The control apparatus of claim 5, further comprising an intake

air controller for determining a correction value for causing an intake air amount into the engine to converge to a desired intake air amount that implements the requested engine output,

wherein the master controller determines the desired value of the master parameter based on the correction value.

15. The control apparatus of claim 6, further comprising an intake air controller for determining a correction value for causing an intake air amount into the engine to converge to a desired intake air amount that implements the requested engine output,

wherein the master controller determines the desired value of the master parameter based on the correction value.

16. The control apparatus of claim 14, wherein the intake air controller is configured to perform a response assignment control that is capable of specifying a response speed of the intake air amount to the desired intake air amount,

wherein the intake air controller sets the response speed in accordance with whether the requested engine output is increasing or decreasing.

17. The control apparatus of claim 14, wherein the intake air controller sets the response speed of the intake air in accordance with load of the engine.

25

18. The control apparatus of claim 14, wherein an operation cycle in which the correction value is determined by the intake air controller is set to be longer than an operation cycle in which the master parameter and the slave parameter are determined by the master controller and the slave controller.

30

19. The control apparatus of claim 6, further comprising a fail safe means for stopping the control by the compression ratio controller, the lift controller and the phase controller if a failure is detected in one of a variable compression ratio mechanism controlled by the compression ratio controller, a variable lift mechanism controlled by the lift controller and a variable phase mechanism controlled by the phase controller, and for controlling an ignition timing by a response assignment control to maintain a rotational speed of the engine at a predetermined value.

10

20. A method for controlling an engine having a variable lift mechanism that is capable of changing a lift amount of a valve of the engine and a variable compression ratio mechanism that is capable of changing a compression ratio in a combustion chamber of the engine, comprising the step of:

15

controlling the variable lift mechanism and the variable compression ratio mechanism so that a rate that the compression ratio decreases is faster than a rate that the lift amount increases when a requested engine output is increasing.

20

21. The method of claim 20, wherein the engine further has a variable phase mechanism that is capable of changing a phase of the valve; wherein the method further comprises the step of:

controlling the variable phase mechanism and the variable compression ratio so that a rate that the compression ratio decreases is faster than a rate that the phase is retarded when the requested engine output is increasing.

25

22. A method for controlling an engine having a variable lift mechanism that is capable of changing a lift amount of a valve of the

30

engine and a variable compression ratio mechanism that is capable of changing a compression ratio in a combustion chamber of the engine, comprising the step of:

controlling the variable lift mechanism and the variable
5 compression ratio mechanism so that a rate that the lift amount decreases is faster than a rate that the compression ratio increases when a requested engine output is decreasing.

10 23. The method of claim 22, wherein the engine further has a variable phase mechanism that is capable of changing a phase of the valve; wherein the method further comprises the step of:

controlling the variable phase mechanism and the variable
compression ratio so that a rate that the phase is advanced is faster than a
15 rate that the compression ratio increases when the requested engine output is decreasing.

24. A method for controlling an engine, comprising the steps of:

(a) selecting one of a compression ratio in a combustion chamber of
20 the engine and a lift amount of a valve of the engine as a master parameter and selecting the other as a slave parameter based on a requested engine output;

(b) determining a desired value for the master parameter based on the requested engine output;

25 (c) controlling the master parameter to converge to the desired value determined in the step (b);

(d) determining a desired value for the slave parameter based on an actual measured value of the master parameter that is acquired as a result of the control of the master parameter in the step (c); and

30 (e) controlling the slave parameter to converge to the desired value

determined in the step (d),

wherein the control of the master parameter and the control of the slave parameter allow a changing rate of the master parameter to be faster than a changing rate of the slave parameter.

5

25. The method of claim 24, wherein the step (a) comprises selecting the compression ratio as the master parameter and selecting the lift amount as the slave parameter when the requested engine output is increasing.

10

26. The method of claim 24, wherein the step (a) comprises selecting the lift amount as the master parameter and selecting the compression ratio as the slave parameter when the requested engine output is decreasing.

15

27. A method for controlling an engine, comprising the steps of:

(a) selecting one of a compression ratio in a combustion chamber of the engine, a lift amount of a valve of the engine and a phase of the valve as a master parameter and selecting the others as slave parameters based on a requested engine output;

20

(b) determining a desired value for the master parameter based on the requested engine output;

(c) controlling the master parameter to converge to the desired value determined in the step (b);

25

(d) determining desired values for the slave parameters based on an actual measured value of the master parameter that is acquired as a result of the control of the master parameter in the step (c); and

(e) controlling the slave parameters to converge to the desired values determined in the step (d),

30

wherein the control of the master parameter and the control of the

slave parameter allow a changing rate of the master parameter to be faster than a changing rate of the slave parameter.

28. The method of claim 27, wherein the step (a) comprises selecting
5 the compression ratio as the master parameter and selecting the lift
amount and the phase as the slave parameters when load of the engine is
extremely low and the requested engine output is increasing.

29. The method of claim 27, wherein the step (a) comprises selecting
10 the phase as the master parameter and selecting the lift amount and the
compression ratio as the slave parameters when load of the engine is
extremely low and the requested engine output is decreasing.

30. The method of claim 27, wherein a desired value of the lift
15 amount is determined based on an actual measured value of the phase that
is acquired as a result of controlling the phase when load of the engine is
extremely low.